

Coating Thickness Tester

User Manual



**Please read this manual before switching the unit on.
Important safety information inside.**

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1.General information

The DT-156 coating thickness gauges work either on the magnetic induction principle or on the eddy current principle, depending on the type of probe used. You can select the type of probe via MENU system, or it will be work automatically.

The gauges conform to the following industrial standards:

GB/T 4956-1985

GB/T 4957-1985

JB/T 8393-1996

JJG 889-95

JJG 818-93

Features

- Measured Coatings: Non-magnetic coatings(e.g. paint, zinc)on steel; Insulating coatings(e.g. paint, anodizing coatings)on no-ferrous metals
- Operating with MENU easily
- Two measuring mode: CONTINUE and SINGLE mode
- Two working mode: DIRECT and GROUP mode(4 groups)
- Statistic Display: AVG, MAX, MIN, NO., S.DEV
- One point calibrating and two points calibrating independently for each working mode
- Zero calibrating easily
- Memory for 320 readings(80 for each group)
- Delete single readings and all group readings easily
- High alarm and Low alarm for all working mode
- Low battery, error indication
- USB interface for PC analysis software
- Disable Auto-Power-off function via MENU setting.

1-1.Application

- This compact and handy gauge is designed for non-destructive, fast and precise coating thickness measurement. The principal applications lie in the field of corrosion protection. It is ideal for manufacturers and their customers, for offices and specialist advisers, for paint shops and electroplaters, for the chemical, automobile, shipbuilding and aircraft industries and for light and heavy engineering.
- DT-156 gauges are suitable for laboratory, workshop and outdoor use.
- The probe can work on both principles, magnetic induction and on the eddy current principle. One probe only is required for coating measurement both on ferrous and non-ferrous metal substrates. It is adaptable to specific tasks: i.e. they can be used on special geometries or on materials with special properties.

1-2.Description Of The Gauge

- For measurement on steel substrates, the gauge work on the magnetic induction principle, for measurement on non-ferrous metal substrates, it works on the eddy current principle.
- Measurement values and user information are shown on LCD. A display back light ensures easy reading of screen data in dark conditions.
- Two different operating modes are available: DIRECT mode and GROUP mode.
- DIRECT mode is recommended for simple, quick, occasional measurements. It provides statistical analysis. Single values are not saved. The statistical analysis program can evaluate 80 readings.
- GROUP mode permits measurement and storage of readings in a free programmable memory. A maximum of 400 readings and 4 series of measurements can be analyzed according to various statistical criteria.

1-3.Supply Schedule

- Gauge with two 1.5V battery, plastics carrying case, operating instructions (English), steel and aluminum substrate.
- USB connecting cable
- Program disc for Windows 98/2000/xp/Vista/7

1-4.Probe

The Probe systems are spring-mounted in the probe sleeve. This ensures safe and stable positioning of the probe and constant contact pressure. A V-groove in the sleeve of the probes facilitates reliable readings on small cylindrical parts. The hemispherical tip of the probe is made of hard and durable material. Hold the probe by the spring mounted sleeve and put on measuring object.

1-5.Specifications

Sensor probe	F	N
Working principle	Magnetic induction	Eddy current principle
Measuring range	0~1250μm 0~49.21mils	0~1250μm 0~49.21mils
Guaranteed tolerance (of reading)	0~850μm (±3%+1μm) 850μm~1250μm (±5%) 0~33.46 mils (±3%+0.039mils) 33.46mils~49.21mils (±5%)	0~850μm (±3%+1.5μm) 850μm~1250μm (±5%) 0~33.46mils (±3%+0.059mils) 33.46mils~49.21mils (±5%)
Precision	0~50μm (0.1μm) 50μm~850μm(1μm) 850μm~1250μm (0.01mm) 0~1.968mils (0.001mils) 1.968mils~33.46mils (0.01mils) 33.46mils~49.21mils (0.1mils)	0~50μm (0.1μm) 50μm~850μm(1μm) 850μm~1250μm (0.01mm) 0~1.968mils (0.001mils) 1.968mils~33.46mils (0.01mils) 33.46mils~49.21mils (0.1mils)
Minimum curvature radius	1.5mm	3mm
Diameter of Minimum area	7mm	5mm
Basic critical thickness	0.5mm	0.3mm
Working temperature	0°C~40°C(32°F~104°F)	
Working relative humidity	20%~90%	

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Size(H×D×W): 110×50×23mm

Weight: 100g

1-6.Front View

1-Probe

2-Power ON/OFF key

3-Zero Calibration key

4-Down/Right key

5-Blue key for ESC/NO/BACK function in menu mode, or backlight
ON/OFF In working mode

6-Main display for coating thickness

7-Measuring unit

8-NFe: indicates readings on non-ferrous metals;
Fe: indicates readings on ferrous metals

9-Indicates the probe working principle: AUTO, Magnetic induction
or Eddy current

10-Indicates that the gauge is currently controlled via pc

11-USB connecting port

12-Low battery

13-Working mode indication:DIRECT or GROUP

14-Statistic display:AVG, MAX, MIN, SDEV

15-The statistic number of measuring
readings

16-Red key for OK/YES/ MENU/
SELECT in menu mode

17-Up/Left key



2.Preparing

2-1.Power Supply

For checking the battery's state of charge please press  key:

No LC display: Battery missing or battery charge too low to illuminate display.

■ Display: gauge switches off after about one second: Replace battery immediately.

Note that the gauge will make faulty measurements if the voltage is very low.

2-2.Replacing The Battery

- Place the gauge upside down on a suitable surface.
- Remove the screws from the battery compartment with a cross tip screwdriver.
- Raise the lid of the compartment.
- Remove battery.
- Insert new battery.
- Close the lid and fasten with screw.

Caution:Make sure the anode and cathode are correctly positioned.

2-3.Menu System and Basic Settings

2-3-1 Menu System

Press  to power on; the gauge will work in measuring mode. Press red-bar button into MENU mode. See following MENU system arranges:

NOTE: MENU system arranges need to be known well for your works.

Menu

>Statistic view

 >>Average view

 >>Minimum view

 >>Maximum view

 >>Number view

 >>Sdev. view

>Options

 >>Measure mode

 >>>Single mode

 >>>Continuous mode

- >>Working mode
 - >>>Direct
 - >>>Group 1
 - >>>Group 2
 - >>>Group 3
 - >>>Group 4
- >>Used probe
 - >>>AUTO
 - >>>Fe
 - >>>No Fe
- >>Unit settings
 - >>>um
 - >>>mils
 - >>>mm
- >>Backlight
 - >>>ON
 - >>>OFF
- >>LCD Statistic
 - >>>Average
 - >>>Maximum
 - >>>Minimum
 - >>>Sdev.
- >>Auto power off
 - >>>Enable
 - >>>Disable
- >Limit
 - >>Limit settings
 - >>>High limit
 - >>>Low limit
 - >>Delete limit
- >Delete
 - >>Current data
 - >>All data
 - >>Group data
- >Measurement view
- >Calibration
 - >>Enable
 - >>Disable
 - >>Delete Zero N
 - >>Delete Zero F

2-3-2 Basic Settings

Please refer to the MENU arrange. According to the LCD indication, Press red-bar button for OK/YES/MENU/SELECT operating functions. Press blue-bar button for ESC/NO/BACK operating functions. Press the UP/DOWN button to switch the selected item.

2-3-2-1 Measure mode

- Continuous measurement mode: It can sometimes be of advantage if the probe does not need to be raised between each measurement so that there is a running display of readings. In continuous mode, readings are not accompanied by a bleep. All readings taken in this mode will automatically be entered into the statistics program as long as sufficient memory is available.
- Single mode: In Single mode, readings are accompanied by a bleep. Besides, Others are same as Continuous measurement mode.

2-3-2-2 Used probe

The probe can work in three modes.

AUTO: The probe can automatically select the working mode. When Placed on steel (magnetic substrates), it will work in magnetic induction principle. When placed on no-ferrous metals, it will work in eddy current principle.

Fe: The probe works in magnetic induction principle.

No-Fe: The probe works in eddy current principle.

2-3-2-3 Unit settings

You can switch from Metric units (μm , mm) to imperials (mils). In " μm " mode, the unit will switch to "mm" automatically when value of reading exceeds 850 μm , see the specification section for more details.

2-3-2-4 Total-Reset

A total reset erases data from all memories. This includes all sets of readings of all work modes plus their associated statistics, calibration values and tolerance limits.

- Switch off gauge.
- Press ZERO + simultaneously.
- The LC display "sure to reset", Press red-bar button for YES, or blue-bar button for NO.
- The gauge will restart automatically.

2-3-2-5 Backlight

You can select ON/OFF in MENU system. Besides, in measuring mode, Press the blue-bar button once to switch ON/OFF backlight.

2-3-2-6 LCD Statistic

In Menu system mode, The statistic display can be selected between Average, Maximum, Minimum and Sdev. When return to measurement mode, it will be displayed on the lower right of LCD. At the same time, the statistic number of measuring readings is displayed on the lower left of LCD. Via "statistic view" item in MENU system, you can look through all statistic values for current group.

2-3-2-7 Measurement view

Via "Measurement view" in MENU, you can look through all measurement readings for current group.

2-3-2-8 Auto power off

You can disable Auto-power-off via MENU system or the gauge will power off automatically for about 3 minutes.

3.measuring, Storage And Data Processing In Direct and Group Mode

This gauge offers two operating modes: DIRECT and GROUP mode. The GROUP mode includes GRO 1~4.

- DIRECT mode is intended for quick occasional readings. In this mode, individual readings are logged to memory provisionally. When Power off or Switch to GROUP mode, all readings will be cleaned. But the statistic values won't be changed until logging new measurement readings. The readings and statistical values can be shown on the LC display. The statistical analysis program can evaluate 80 readings. When the memory is full, new readings will replace old readings. In this mode, it has individual calibration values and limit values.
- In GROUP mode, every group memory can store a maximum of 80 single readings, and 5 Statistic values. Calibration values and limit values can individually be set and stored for every group. When the memory is full, measuring will make sequentially, but not be stored and statistic values won't be changed. If need, you can delete group data and statistic values, and reset calibrate values and limit values.

- You can select DIRECT and GROUP mode in MENU system.
NOTE: in order to work in GROUP mode, e.g. to calibrate, take readings, set limit, the word "GROX" must appear on the LC display, if not, you can set measurement mode in MENU system.
- Press while holding the probe in the air. The gauge will work in DIRECT mode. And the last reading will be shown (if available).

4. Calibration and Measurement

4-1. General Hints for Calibration

4-1-1. Calibration methods

There are four different methods available for calibration:

- Basic calibration: recommended for measurement on even surfaces and if the measuring object has the same material, size and curvature as the zero plate attached in the casing.
- Zero-point calibration: recommended if measuring errors up to $\pm(3\% \text{ of reading plus constant error of probe})$ are permitted.
(Example for constant of probe \bar{e} error: Fe 1 μm ; no-Fe 1.5 μm)
- One-point calibration (calibrating using a calibration foil): recommended if readings to be expected will be close to the calibration value and if the permitted error of probe will be max. $\pm(1\% \dots 3\% \text{ of reading plus constant probe error})$
- Two-point calibration (using a set of two calibration foils):
 - A) Recommended for measurements on rough surfaces.
 - B) Recommended for precise measurements on smooth surface if the thickness to be expected lies between that of the two calibration foils.

4-1-2. Storing Calibration Values

If the gauge is calibrated for a particular purpose, the calibration values will be stored in memory until changed.

NOTE: The calibration procedure should be restarted from the beginning if

- An incorrect reading has been taken.
- An incorrect command has been entered.
- The gauge has switched off.

4-1-3.Calibration Example

Calibration is the most important requirement for accurate measurement. The more closely the calibration sample matches the product sample, the more accurate the calibration, and therefore the reading, will be. If for instance, a product is to be measured on a steel cylinder, quality ST37(mild steel), diameter 6mm, the calibration of the uncoated sample must take place on a steel cylinder of similar quality with the same diameter.

The calibration sample must correspond to the product sample in the following ways:

- Curvature radius
- Substrate material properties
- Substrate thickness
- Size of measuring area
- The point at which the calibration is made on the calibration sample must always be identical with the point of measurement on the product itself, especially in the case of corners and edges of small parts

4-1-4.High-Accuracy Calibration

To achieve high-accuracy readings, it is advisable to log calibration values (both zero values and calibration foil values) several times in succession. In this way, the gauge will automatically establish a mean calibration value. For more details see 4-2 special hints for calibration. The high-accuracy calibration is an obvious advantage when calibrating on uneven, e.g. shot-blasted, surfaces.

4-1-5.Cleaning the Measuring Point

Before calibration the measuring point the probe tip must be free from grease, oil, scraps of metal, etc. The slightest impurity will affect measurement and distort readings.

4-2.Special Hints for Calibration

The basic calibration stored in the gauge should only be used for measurements on even surfaces, i.e. on steel components made of conventional steel(mild steel)or on aluminum components.

Firstly, you can turn into Calibration Mode via MENU (Menu-> Calibration->Enable) system. Then the LC will display "Cal n(or 1~2) Zero n(or y)". The "n" means not any point calibration and Zero calibration, and "y" means "there is Zero calibration". "Cal 1~2" means "There is One or Two point Calibration". After finishing all Calibration task, we advise that you disable calibration via MENU system.

Preparing to make calibration:

- Switch the gauge on (far from any metal at least 10cm).
- Substrate sample and necessary foils (calibration standard).
- Set woke mode: continuous or single via MENU.

4-2-1.Zero-point Calibration (no need to enable calibration)

- Place the probe on uncoated sample (zero coating thickness) vertically and rapidly.
- The LC display <xx μm >. Operating is different in continuous mode and single mode. See the work mode section for more details. Then, raise the probe rapidly (far from metal substrate at least 10cm)
- Press and hold Zero button for about 1.5seconds, the LC display 0.0 μm . The calibration is finished.
- Repeat this procedure several times. The calibration system always saves the mean value of the previous calibration point.

NOTE:You can delete the old zero point calibration before making a new zero point calibration via MENU system if existent. The meter always calculates the mean of 5 calibration readings furthest. When full, the newest calibration value will replace the oldest calibration value. We suggest that you make a Zero calibration when starting a measurement.

4-2-2. One-point Calibration

This method is recommended for high precision measurements, measurements on small parts and on hardened and low-alloy steel.

- Zero-point calibration according to section 4-2-1
- Lay the calibration foil on an uncoated sample, apply the probe and raise it if steady. Press UP or DOWN to adjust required foil thickness. The thickness of the foil should be roughly equivalent to the estimated coating thickness.
- Repeat step 2 several times. It will get the mean value of previous calibration readings.
- Now take readings by placing the probe on the coating and raise it if steady.
- It may be necessary to delete calibration, e.g. after entry of a faulty calibration value: MENU->delete->delete group data (NOTE: It will delete all data, limit data, one-point and two-point calibrations except for zero-point calibration).
- This will reactivate the default basic calibration for use on even surfaces.

NOTE: The meter calculates the mean of 5 calibration readings furthest. When full, the newest calibration value will replace the oldest calibration value.

- Press blue-bar button to exit current calibration. Or else, after about 30 seconds, the calibration will become effective automatically.
- Press Zero button to make current calibration effective compulsively. Even while a series of measurements is being taken, foil calibration can be carried out often as necessary. The old calibration will be overwritten; the Zero calibration remains in memory.

4-2-3. Two-point Calibration

- Suggest that gauge is in single work mode. If necessary switch to the mode as MENU system. This method requires the use of two different foils. The thicker one should be, if possible, 1.5times as thick as the thin one.
- For best results, the thickness to be expected should be somewhere between the two calibration values.
- This method is especially suitable for taking measurements on rough shot-blasted surfaces or for high-precision readings. It is advisable to take a mean for several times. This considerably reduces the

effect of scattering which occurs during calibration of upper and lower values.

The calibration foils may be used in any order.

- Zero-point calibration according to section 4-2-1
- The first point calibration according to section 4-2-2
- Repeat the step 2.
- Take readings by placing the probe on the coating to be measured and raise it after the beep. The reading is shown on display.

NOTE:

- Apply the probe to test sample several times.
- The thickness of the foil should be roughly equivalent to the estimated coating thickness.
- Even while a series of measurements is being taken, foil calibration can be carried as often as necessary. The old calibration will be overwritten; the ZERO calibration remains in memory until make the zero point calibration.
- See one-point calibration for more information.

4-2-4. Shot-blased Surfaces

The physical nature of shot-blased surfaces results in coating thickness reading that are too high. The mean thickness over the peaks can be determined as follows (not that the statistics program is of great benefit in this procedure):

Method A:

- The gauge should be calibrated according to 4-2-2 or 4-2-3. Use a smooth calibration sample with the same curvature radius and the same substrate as the later measuring sample.
- Now take approx. 10 readings on the uncoated, shot-blased sample to produce the mean value X_0 .
- After this take approx. 10 further readings on coated, shot blasted test sample to produce the mean value X_m
- The difference between the two mean values is the mean coating thickness X_{eff} over the peaks. The greater standard deviation s of the two values X_m and X_0 should also be taken into consideration:
$$X_{eff} = (X_m - X_0) \pm S$$

Method B:

- Carry out a zero calibration of 10 readings on a shot-blasted, uncoated sample. Then carry out a foil calibration on the uncoated substrate. The foil set should consist of a number of individual foils of max. 50 microns thickness each and should roughly correspond to the estimated coating thickness.
- The coating thickness can be read directly from display and should be averaged from 5....10 single measurements. The statistics function is useful here.

Method C:

This method also gives reliable results. Simply follow the two-point calibration method using two foils as described in section 4.2.3. For a maximum approach to the respective nature of surface, the foil value can be reached by using several foils – 50um each. The mean coating thickness should be calculated from 5...10 readings. The statistics program is very useful here.

NOTE: For coatings thicker than 300 um, the influence of roughness generally is of no importance and it will not be necessary to apply above calibration methods.

4-3.General Remarks on Measurement

- After careful calibration has been made, all subsequent measurements will lie within the guaranteed measuring tolerance.
- Strong magnetic fields near generators or live rails with strong currents can affect the reading.
- When using the statistics program for obtaining a mean value it is advisable to place the probe several times at a typical measuring spot. Any false readings or outliers can be removed immediately via MENU system.
- The final reading derives from the statistical calculation and from the guaranteed tolerance levels of the gauge.
- Coating Thickness D = $X \pm s \pm \mu$.

Example:

Readings: $150\mu\text{m}$, $156\mu\text{m}$, $153\mu\text{m}$

Mean value: $X=153\mu\text{m}$

Standard deviation: $s=\pm3\mu\text{m}$

Measuring uncertainty: $\mu=\pm(1\% \text{ of reading} + 1\mu\text{m})$

$$D=153\pm3\pm(1.53\mu\text{m}+1\mu\text{m})$$

$$=153\pm5.5\mu\text{m}$$

5. Limit Function

- Limits can be entered in DIRECT and a selected GROUP memory at any time, i.e. before, during and after a series of measurements. There is practical use for limits.
- Any reading which falls outside the set tolerance limits will be registered by a warning indication:

H: reading above HI limit.

L: reading below LO limit.

Please set the limit values using MENU system.

6. Measurement Using Statistics

The gauge calculates statistics from a maximum of 80 readings (GRO1~GRO4: in total, a maximum of 400 readings can be stored). In addition, readings can't be stored in DIR mode, but it can calculate statistics as GRO1~GRO4. When power off or changing Work Mode (see MENU system for details), the DIR statistics will be lost. The following statistical values are calculated:

NO.: Number of readings in Work Mode.

AVG: Average value.

Sdev. : Standard deviation.

MAX: Maximum reading.

MIN: Minimum reading.

6-1.Statistical Terms

Average value(\bar{X})

The sum of readings divided by the number of readings.

$$\bar{X} = \sum X / n$$

Standard Deviation(Sdev.)

The sample standard deviation is a statistic that measures how "spread out" the sample is around the sample mean. The sample standard deviation increases with increasing spread out. The standard deviation of a set of numbers is the root mean square of the variance S^2

The variance of a list is the square of the standard deviation of the list, that is, the average of the squares of the deviations of the numbers in the list from their mean divided by the (number of readings - 1)

$$\text{Variance } S^2 = \sum (x - \bar{x})^2 / (n - 1)$$

$$\text{Standard deviation } S = \sqrt{S^2}$$

NOTE:

Deletion must take place immediately after an outlier or erratic reading has been taken. See the Delete function in MENU system.

6.2.Storage Capacity Overflow

- In GROUP mode, If the storage capacity is exceeded, statistics will not be updated, although measurement can continue. If the memory is full, subsequent readings will be omitted from the statistics. They will be marked with "FULL" in LCD (In single measuring mode).
- In DIRECT mode, if the memory is full. The newest reading will replace the oldest reading. And the statistics will be updated.

7.Delete Functions

In MENU system, you can find following function:

- Delete current data: If you find the last measuring reading is wrong, you can delete it via this function. At the same time, the statistics will be updated.
- Delete all data: You can delete all data and statistics of the Current Work Mode.
- Delete Group data: this function includes "Delete all data" function.

In addition, This function will delete HIGH alarm, Low alarm, and One&Two point calibrations.

8.Gauge Control Via PC

All measuring readings of all work modes can be downloaded to PC via USB port for data analysis. See software guide for more details.

9.Trouble Shooting

The following list of error messages explains how to identify and eliminate faults.

Err1, Err2, Err3: Connecting of probe fault; Deviant signal.

Err1: Eddy current probe.

Err2: Magnetic induction probe.

Err3: Both probes.

Err4, 5, 6: reserved.

Err7: Thickness fault.

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Rev.100315

